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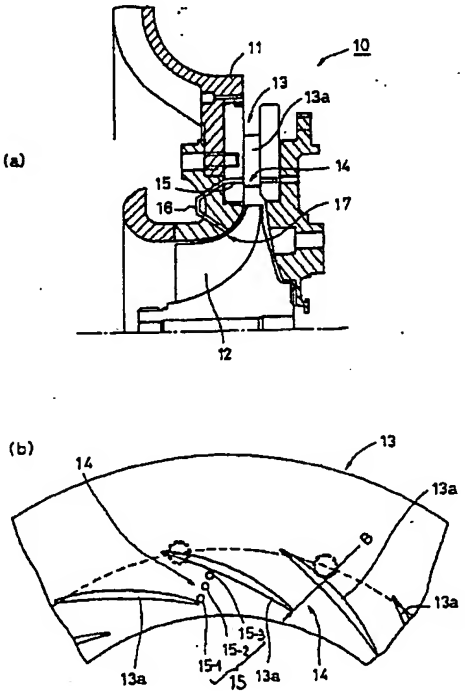
(54)【発明の名称】　ディフューザつき遠心圧縮機

(57)【要約】

【課題】　羽根つきディフューザのベーンの形状や取付構造などを変えずに流量特性を改善することができるディフューザつき遠心圧縮機を提供すること。

【解決手段】　ディフューザ１３のスロート部14にバイパス孔１５を形成し、このバイパス孔１５と圧縮機吸込み側の低圧力部であるインペラ１２の外周と対向する入り口部１７とを連通するバイパス流路１６を設ける。これにより、圧縮機の吐出流量を小さくしてもバイパスさせた流体でディフューザ１３部分を流れる流量を確保することができ、サージングを防止するなどの流量特性を改善する。さらに、ディフューザ１３のベーンの形状や可変機構への取付構造などを何等変更せずに、バイパス孔１５とバイパス流路１６を形成するだけで良く、構造も簡単である。



【特許請求の範囲】
【請求項１】　ディフューザを備えた遠心圧縮機の壁面境界層剥離部にバイパス孔を形成し、このバイパス孔と圧縮機吸込み側の低圧力部とを連通するバイパス流路を設けてなることを特徴とするディフューザつき遠心圧縮機。
【請求項２】　前記ディフューザを羽根つきディフューザで構成し、前記壁面境界層剥離部をディフューザのスロート部とし、このスロート部にバイパス孔を形成してなることを特徴とする請求項１記載のディフューザつき遠心圧縮機。
【請求項３】　前記圧縮機の吸込み側の低圧力部をインペラの低圧力部またはインペラへの吸込み流路としたことを特徴とする請求項１または２記載のディフューザつき遠心圧縮機。
【請求項４】　前記バイパス孔を複数の小径孔と、これら複数の小径孔の背部を連通する集合部とで構成したことを特徴とする請求項１～３のいずれかに記載のディフューザつき遠心圧縮機。
【請求項５】　前記ディフューザのスロート部のバイパス孔の総断面積をスロート部の総入り口幅の２０％以下としたことを特徴とする請求項２～４のいずれかに記載のディフューザつき遠心圧縮機。
【請求項６】　前記バイパス流路にバイパス流量を制御する流量制御手段を設けたことを特徴とする請求項１～５のいずれかに記載のディフューザつき遠心圧縮機。
【請求項７】　前記バイパス孔と前記圧縮機の吸込み側の低圧力部へのバイパス流路接続部の開口比を変えて流量を制御するようにしたことを特徴とする請求項１～６のいずれかに記載のディフューザつき遠心圧縮機。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、ディフューザを備えた遠心圧縮機の改良に関し、ディフューザのスロート部等の壁面境界層剥離部と圧縮機吸込み側のインペラの低圧力部等とをバイパス流路で連通して流量特性の改善を図るようにしたものである。
【０００２】
【従来の技術】ガスタービンやターボチャージャなどに用いられる遠心圧縮機では、効率向上を図るためディフューザが用いられており、たとえば図６（ａ）に示すように、コンプレッサハウジング１内にインペラ２が回転可能に支持され、コンプレッサハウジング１の空気入口から吸引した空気にインペラ２で遠心力を与え、その運動エネルギをディフューザ３および図示しないスクロール部で圧力エネルギに変換して送り出すようになっている。
【０００３】このように運動エネルギを圧力エネルギに変換するディフューザ３には、図６（ｂ）に示すように、羽根４のあるものと羽根のないものがあり、羽根なしディフューザでは、比較的広い流量範囲での使用が可能であるが、その効率や圧縮比向上は羽根付きディフューザ（ベーンドディフューザ）に比べて小さい。
【０００４】そこで、羽根つきディフューザのベーンを可変構造とした可変ディフューザを用いてスロート面積を変化させて流量特性を改善することが行われている。
【０００５】
【発明が解決しようとする課題】ところが、可変ディフューザを用いると、ベーンと固定側のハウジングとの間にベーンを動かすための隙間が必要であり、この隙間部分の二次流れによって損失が生じたり、迎え角の変化による流れの剥離（壁面境界層の剥離）などが発生し、設計点以外での効率低下を招くなどの問題がある。
【０００６】また、羽根なしディフューザにおいても流れの局所的な境界層の剥離が生じる問題がある。
【０００７】この発明は、かかる従来技術の課題に鑑みてなされたもので、羽根つきディフューザのベーンの形状や取付構造などを変えずに流量特性を改善することができるとともに、羽根なしディフューザの流量特性を改善することもできるディフューザつき遠心圧縮機を提供しようとするものである。
【０００８】
【課題を解決するための手段】上記課題を解決するためこの発明の請求項１記載のディフューザつき遠心圧縮機は、ディフューザを備えた遠心圧縮機の壁面境界層剥離部にバイパス孔を形成し、このバイパス孔と圧縮機吸込み側の低圧力部とを連通するバイパス流路を設けてなることを特徴とするものである。
【０００９】この発明によれば、バイパス孔とバイパス流路によって圧縮機吸込み側のバイパスさせるようにしており、境界層の剥離を防止して性能改善を図るようにし、サージングを防止するなどの流量特性を向上するようにしている。
【００１０】また、この発明の請求項２記載のディフューザつき遠心圧縮機は、請求項１記載の構成に加え、前記ディフューザを羽根つきディフューザで構成し、前記壁面境界層剥離部をディフューザのスロート部とし、このスロート部にバイパス孔を形成してなることを特徴とするものである。
【００１１】この発明によれば、バイパス孔とバイパス流路によって圧縮機の吐出流量を小さくしてもバイパスさせるようにしてディフューザ部分を流れる流量を確保するようにしており、サージングを防止するなどの流量特性を向上するようにしている。
【００１２】また、この発明の請求項３記載のディフューザつき遠心圧縮機は、請求項１または２記載の構成に加え、前記圧縮機の吸込み側の低圧力部をインペラの低圧力部またはインペラへの吸込み流路としたことを特徴とするものである。
【００１３】この発明によれば、インペラの低圧力部ま

たはインペラへの吸込み流路の吸込み負圧を利用して効果的にバイパスさせることができ、確実にサージングを防止するなどの流量特性を向上するようにしている。

【0014】さらに、この発明の請求項4記載のディフューザつき遠心圧縮機は、請求項1～3のいずれかに記載の構成に加え、前記バイパス孔を複数の小径孔と、これら複数の小径孔の背部を連通する集合部とで構成したことを特徴とするものである。

【0015】この発明によれば、バイパス孔を複数の孔とし、背部を集合部で連通するようにしており、バイパス孔による流れの乱れを極力防止して性能低下を防止するようにしている。

【0016】また、この発明の請求項5記載のディフューザつき遠心圧縮機は、請求項2～4のいずれかに記載の構成に加え、前記ディフューザのスロート部のバイパス孔の総断面積をスロート部の総入り口幅の20%以下としたことを特徴とするものである。

【0017】この発明によれば、バイパス孔の総断面積をスロート部の総入り口幅の20%以下に制限するようにしており、バイパス孔やバイパス流路による性能低下を1%以内に抑え、性能を確保しつつ流量特性を改善するようにしている。

【0018】さらに、この発明の請求項6記載のディフューザつき遠心圧縮機は、請求項1～5のいずれかに記載の構成に加え、前記バイパス流路にバイパス流量を制御する流量制御手段を設けたことを特徴とするものである。

【0019】この発明によれば、流量制御手段によってバイパス流量を変えることができるようになり、必要な吐出流量に応じた運転や運転回転数などに対応して効率的に運転できるようになる。

【0020】また、この発明の請求項7記載のディフューザつき遠心圧縮機は、請求項1～6のいずれかに記載の構成に加え、前記バイパス孔と前記圧縮機の吸込み側の低圧力部へのバイパス流路接続部の開口比を変えて流量を制御するようにしたことを特徴とするものである。

【0021】この発明によれば、開口比を適切に選ぶことで、バイパス流量を設定できるようになり、必要な流量特性を得ることができるようになる。

【0022】ここで、遠心圧縮機の壁面境界層剥離部とは、遠心圧縮機の吸込み側で流れの剥離が生ずる部分をいい、例えばディフューザのスロート部をあげることができる。

【0023】さらに、ディフューザのスロート部とは、隣接するベーンとの距離が最も小さい部分をいう。

【0024】また、圧縮機吸込み側の低圧力部とは、圧縮機の流体の吸引側で吸込み負圧が生じて低圧力となっている部分をいい、例えばインペラの外周が対向する部分やインペラへの吸込み流路の上流側をあげることができる。

【0025】さらに、ディフューザのスロート部のバイパス孔の総断面積をスロート部の総入り口幅の20%以下とは、バイパス孔の総断面積とスロート部の総入り口幅の比で無次元の値ではないが、そのままの数値で表わして20%以下にすることをいい、これ以上に大きくすると、本来の効率低下を招くことから限界値として定められる。

【0026】また、流量制御手段とは、流量を調整制御できるものをいい、バルブ等を用いることができる。

【0027】さらに、バイパス孔と前記インペラの低圧力部へのバイパス流路接続部の開口比とは、バイパス孔の大きさとバイパス流路のインペラ側の取付部の面積の比をいい、これにより流量を制御することができるようにする。

【0028】

【発明の実施の形態】以下、この発明の実施の形態を図面に基づき詳細に説明する。図1はこの発明のディフューザつき遠心圧縮機の一実施の形態にかかり、（a）は主要部の断面図、（b）は羽根つきディフューザ部分を抽出した正面図である。

【0029】このディフューザつき遠心圧縮機10では、コンプレッサハウジング11に回転可能に支持されたコンプレッサのインペラ12の出側のコンプレッサハウジング11に配置されるディフューザ13が羽根つきの可変ディフューザで構成されており、図示しない可変機構を備えて羽根（ベーン）13aを動かすことができるようになっている。

【0030】この羽根つきの可変ディフューザ13のスロート部14、すなわち、隣接する羽根13aとの間の距離が最も小さい部分に遠心圧縮機の流体の主流の方向と垂直にバイパス孔15が形成してあり、主流の一部をバイパス孔15から分岐して流すことができるようになっている。そして、このバイパス孔15に一端部を連通させてバイパス流路16が接続され、他端部が圧縮機吸込み側の低圧力部であるインペラ12のコンプレッサハウジング11と対向する入り口部17に接続してある。

【0031】したがって、インペラ12でエネルギが加えられた流体（例えば、空気など）の一部が可変ディフューザ13のスロート部14で抽気されてインペラ12の入り口部17に戻されて再循環されることになり、インペラ12を流れる流量に対してディフューザ13を経て吐出される流体流量はバイパス孔15からバイパス流路16を流れる抽気流量の分だけ少なくなる。これにより、インペラ12を流れる流量を確保しつつコンプレッサから吐出させる流量を減少させることができるとともに、ディフューザ13のスロート部14は遠心圧縮機の流量限界を決定する大きな要因であり、この部分からの抽気することにより、ディフューザ13で生じるサージング及びチョークの流量限界を改善することができる。

【0032】このような流量特性の改善のため形成され

るバイパス孔１５は、流量特性の改善効果が最も著しい部分に形成することが有効であり、例えば図１（ｂ）に示すように、ディフューザ１３のスロート部１４の3箇所のバイパス孔１５-1，１５-2，１５-3の3か所のうち実験結果などに基づきいずれか１箇所を選択して形成するようにすれば良い。

【００３３】次に、ディフューザつき遠心圧縮機で一層の流量特性を改善使用とする場合について、図2により説明する。

【００３４】このディフューザつき遠心圧縮機１０では、流量特性の改善のため形成されるバイパス孔１５は、インペラ１２からの主流を乱すことがないように形成することが望ましく１箇所の大きな孔で構成する場合に比べて、図2に示すように、複数のバイパス孔１５（図示例では、５個）で構成するようにすれば、主流の乱れを少なくして効率低下を最少限にすることができる。

【００３５】そして、バイパス孔１５を複数個で構成する場合には、バイパス孔１５の背部となるコンプレッサハウジング１１に凹部を形成して各バイパス孔１５を連通する集合部１５ａとし、この集合部１５ａにバイパス流路１６の一端を接続するようにすれば良い。

【００３６】また、一端をバイパス孔１５を連通する集合部１５ａに接続したバイパス流路１６の他端は、図１で説明したように、圧縮機のインペラ１２の外周部と対向するコンプレッサハウジング１１部分に連通する場合に替え、図2に示すように、インペラ１２への吸込み流路２０の上流側に接続するようにしても良く、この場合にも吸込み流路２０の吸入負圧によって有効にバイパスさせることができる。

【００３７】さらに、このようにバイパス孔１５を複数で構成する場合のバイパス孔1.5の個数および総断面積によって、サージング限界流量などの流量特性が変化するとともに、遠心圧縮機全体の効率も変化する。

【００３８】そこで、バイパス孔１５として、図2（ｂ）に示したように、円周方向等間隔の4か所のスロート部１４に1か所当たり５個ずつ合計２０個の孔をあけ、その総断面積がスロート部１４の幅Ｂに対して１５％，３０％となるように変えて形成した性能特性の実験を行った。その結果を示したのが、図3および図4であり、図3は横軸が質量流量で縦軸が圧力比であり、圧縮機の回転数Ｎを設計回転数の４０％，５０％，７０％，８０％と変化させたものであり、図4は横軸が抽気面積比で縦軸が抽気面積比を０とした場合（抽気を行わない場合）を１００とした場合の効率比である。

【００３９】これら実験から明らかなように、図3から抽気面積を増大することで、圧縮機のサージング限界流量を小さくすることができることが分かるが、一方で図４から抽気面積比の増大によって圧縮機の効率比の低下を招いてしまうことが分かる。

【００４０】したがって、圧縮機の効率の低下を１％以内に抑えるためには、バイパス孔１５の総断面積をスロート部１４の幅Ｂに対して２０％以下にすれば良く、こうすることによってサージング限界などの流量特性を改善しつつ効率低下を許容できる範囲内に抑えることができる。

【００４１】さらに、この発明では、図2および図4に示すように、バイパス孔１５とインペラ１２の吸込み流路２０の上流またはインペラ１２の外周の入り口部１７とを連通するバイパス流路１６に流量制御手段としてのバルブ１８と制御装置１９とを介装し、バイパス孔１５から抽気する流量を制御装置１９によるバルブ１８の開度調整により制御する。

【００４２】これにより、バイパス孔１５の大きさによって抽気面積が一定であっても、抽気流量を変えることができ、例えば遠心圧縮機の回転数を変化させて運転する場合に低速側でバルブ１８を開いておき、高速側で閉じるようにすることで、ガスタービンの起動時にもサージングなどを起こすこと無く運転することが可能となる。

【００４３】また、ディフューザ１３のスロート部１４のバイパス孔１５の総断面積を吸込み流路２０、あるいはインペラ１２の入り口部１７のバイパス流路１６の断面積の半分とするようにしてこれらの面積比で開口比を１／２とするようにして抽気を円滑に行うようにするとともに、バイパス孔１５による主流への影響を少なくする。

【００４４】なお、この開口比を適正化することで、遠心圧縮機の回転数が変化する場合などにサージングが生じ無いように運転するのに必要な抽気流量を得ることもできる。

【００４５】以上のように、これら発明によれば、羽根つきの可変ディフューザ１３のスロート部１４は遠心圧縮機の流量限界を決定する大きな要因であり、この部分に形成したバイパス孔１５から抽気してインペラ１２の入り口部１７などの低圧力部に戻すようにしており、ディフューザで生じるサージングやチョークの流量特性を改善することができる。

【００４６】また、インペラ１２で昇圧されたディフューザ１３からの抽気した流れによりインペラ１２の入り口部１７の流れを変えることができ、これにより流量特性が改善され、サージング限界の向上などが行われる。

【００４７】さらに、ディフューザのベーンの形状や取付構造などを何等変更せずに、バイパス孔１５とバイパス流路１６を形成するだけで良く、構造も簡単である。

【００４８】なお、上記の実施の形態では、ディフューザつき遠心圧縮機として羽根つき可変ディフューザを備えた遠心圧縮機の場合を例に説明したが、固定羽根つきディフューザの場合や羽根なしディフューザの場合にも同様に適用でき、流れの境界層の剥離を防止してサージ

ング発生を制御し、安定作動域の拡大を図ることができる。

【００４９】また、バイパス孔の形成位置もディフューザのスロート部に限らず、局所的な流れの剥離が生ずる部分に形成してこの発明を剥離の制御に適用したり、羽根なしディフューザ等（絞り形状等）にも適用することができる。

【００５０】

【発明の効果】以上、実施の形態とともに具体的に説明したようにこの発明の請求項１記載のディフューザつき遠心圧縮機によれば、バイパス孔とバイパス流路によって圧縮機吸込み側のバイパスさせるようにしたので、境界層の剥離を防止して性能改善を図ることができ、サージングを防止するなどの流量特性を向上することができる。

【００５１】さらに、ディフューザのベーンの形状や取付構造などを何等変更せずに、バイパス孔とバイパス流路を形成するだけで良く、構造も簡単である。

【００５２】また、この発明の請求項２記載のディフューザつき遠心圧縮機によれば、バイパス孔とバイパス流路によって圧縮機の吐出流量を小さくしてもバイパスさせるようにしたので、ディフューザ部分を流れる流量を確保することができ、サージングを防止するなどの流量特性を向上することができる。

【００５３】さらに、この発明の請求項３記載のディフューザつき遠心圧縮機によれば、圧縮機の吸込み側の低圧力部をインペラの低圧力部またはインペラへの吸込み流路としたので、インペラの低圧力部またはインペラへの吸込み流路の吸込み負圧を利用して効果的にバイパスさせることができ、確実にサージングを防止するなどの流量特性を向上することができる。

【００５４】また、この発明の請求項４記載のディフューザつき遠心圧縮機によれば、バイパス孔を複数の孔とし、背部を集合部で連通するようにしたので、バイパス孔による流れの乱れを極力防止して性能低下を防止することができる。

【００５５】さらに、この発明の請求項５記載のディフューザつき遠心圧縮機によれば、バイパス孔の総断面積を２０％以下に制限するようにしたので、バイパス孔やバイパス流路による性能低下を１％以内に抑え、性能を確保しつつ流量特性を改善することができる。

【００５６】また、この発明の請求項６記載のディフューザつき遠心圧縮機によれば、バイパス流路にバイパス流量を制御する流量制御手段を設けたので、流量制御手段によってバイパス流量を変えることができ、必要な吐出流量に応じた運転や運転回転数などに対応して効率的に運転することができる。

【００５７】さらに、この発明の請求項７記載のディフューザつき遠心圧縮機によれば、ディフューザのスロート部のバイパス孔と前記インペラの低圧力部へのバイパス流路接続部の開口比を変えて流量を制御するようにしたので、開口比を適切に選ぶことで、バイパス流量を設定できるようになり、必要な流量特性を得ることができる。

【図面の簡単な説明】

【図１】この発明のディフューザつき遠心圧縮機の一実施の形態にかかり、（ａ）は主要部の断面図、（ｂ）は羽根つきディフューザ部分を抽出した正面図である。

【図２】この発明のディフューザつき遠心圧縮機の他の一実施の形態にかかり、（ａ）は主要部の断面図、（ｂ）は羽根つきディフューザ部分を抽出した正面図である。

【図３】この発明のディフューザつき遠心圧縮機の一実施の形態にかかる質量流量と圧力比の関係を、圧縮機の回転数Ｎを変化させて示すグラフである。

【図４】この発明のディフューザつき遠心圧縮機の一実施の形態にかかる抽気面積比と効率比の関係を示すグラフである。

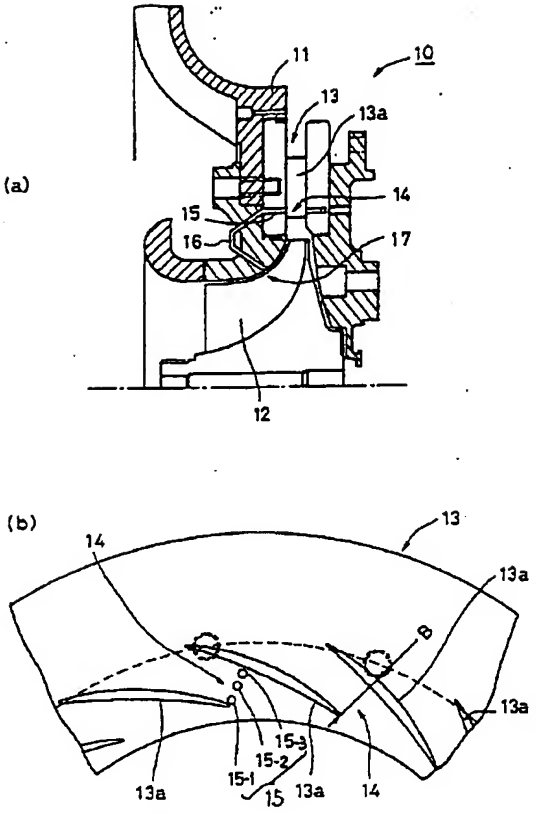
【図５】この発明のディフューザつき遠心圧縮機のさらに他の実施の形態にかかる主要部の断面図である。

【図６】従来の羽根付きディフューザを備えた遠心圧縮機の取付構造の部分断面図および部分正面図である。

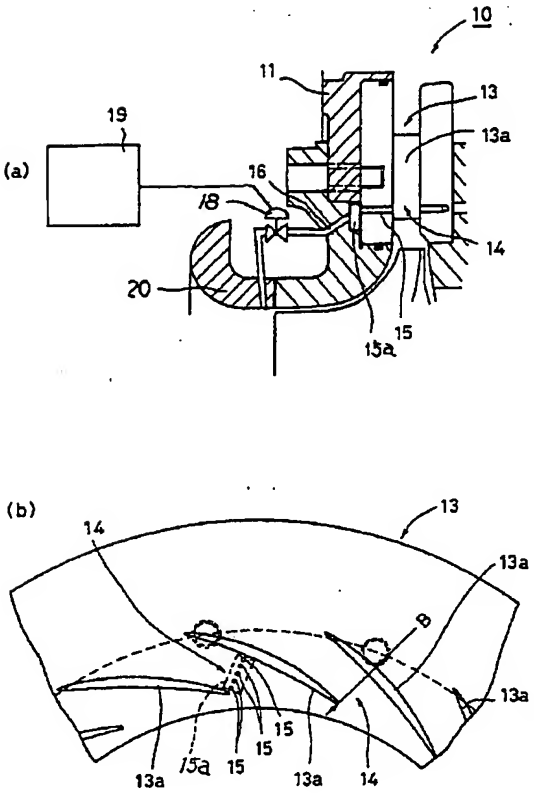
【符号の説明】

１０　ディフューザつき遠心圧縮機
１１　コンプレッサハウジング
１２　インペラ
１３　羽根つき可変ディフューザ
１３ａ　ベーン（羽根）
１４　スロート部
１５　バイパス孔
１５ａ　集合部
１６　バイパス流路
１７　入り口部
１８　バルブ
１９　制御装置
２０　吸込み流路
Ｂ　スロート部の幅

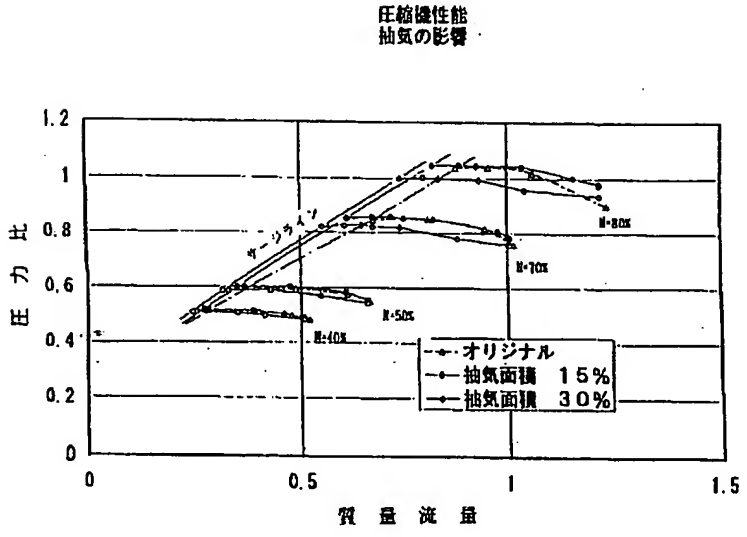
【図1】


(a)
10
11
13
13a
14
15
16
17
12
(b)
13
14
13a
B
13a
15-3
15-2
15-1
15
13a
14

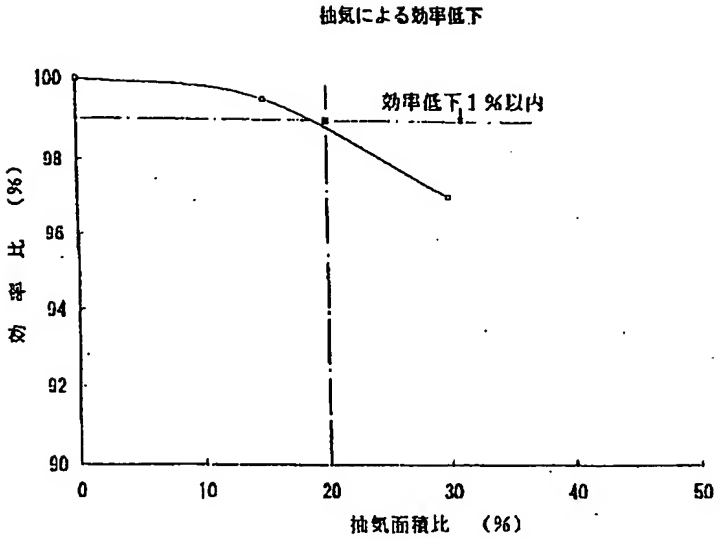
【図2】


10
(a)
19
11
13
13a
16
18
14
20
15a
15
(b)
13
14
13a
B
13a
13a
15a
15
15
13a
14

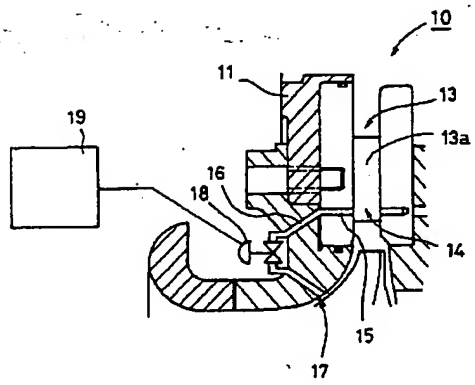
【図3】


圧縮機性能
抽気の影響
圧力比
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
質量流量
N=80%
N=70%
N=50%
N=40%
オリジナル
抽気面積　15%
抽気面積　30%

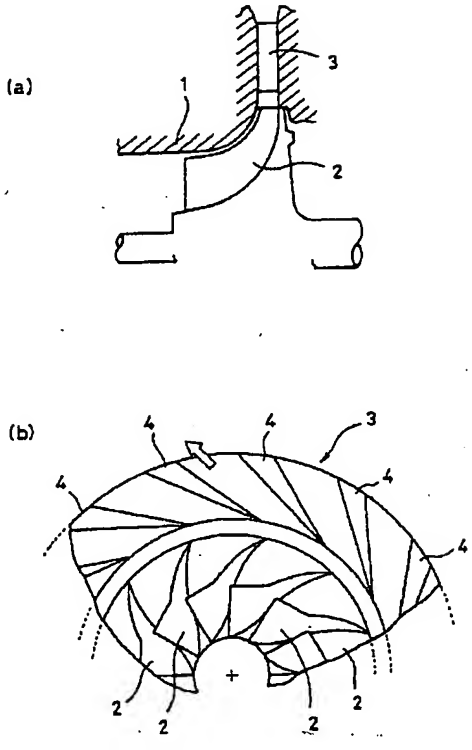
【図4】


抽気による効率低下
効率低下1％以内
効率比（％）
100
98
96
94
92
90
0
10
20
30
40
50
抽気面積比　（％）

【図5】


10
11
13
13a
19
16
18
14
15
17

【図6】


(a)
1
2
3
(b)
4
4
4
3
4
4
2
2
2
2
2

フロントページの続き

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JP 9-119396

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The centrifugal compressor with a diffuser characterized by coming to prepare the bypass passage which forms a bypass hole in the wall surface boundary-layer-separation section of the centrifugal compressor equipped with the diffuser, and opens this bypass hole and the low pressure section of a compressor suction side for free passage.
[Claim 2] The centrifugal compressor with a diffuser according to claim 1 which constitutes said diffuser from a battledore-and-shuttlecock diffuser, makes said wall surface boundary-layer-separation section the throat section of a diffuser, and is characterized by coming to form a bypass hole in this throat section.
[Claim 3] The centrifugal compressor with a diffuser according to claim 1 or 2 characterized by making the low pressure section of the suction side of said compressor into the low pressure section of an impeller, or the sink passage to an impeller.
[Claim 4] The centrifugal compressor with a diffuser according to claim 1 to 3 characterized by constituting said bypass hole from the set section which opens the regions of back of two or more minor diameter holes and the minor diameter hole of these plurality for free passage.
[Claim 5] The centrifugal compressor with a diffuser according to claim 2 to 4 characterized by making the gross area of the bypass hole of the throat section of said diffuser into 20% or less of the total entry width of face of the throat section.
[Claim 6] The centrifugal compressor with a diffuser according to claim 1 to 5 characterized by preparing the flow rate control means which controls a bypass flow rate in said bypass passage.
[Claim 7] The centrifugal compressor with a diffuser according to claim 1 to 6 characterized by changing the throat area ratio of the bypass passage connection to the low pressure section of the suction side of said bypass hole and said compressor, and controlling a flow rate.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About amelioration of the centrifugal compressor equipped with the diffuser, this invention opens the wall surface boundary-layer-separation sections, such as the throat section of a diffuser, the low pressure section of the impeller of a compressor suction side, etc. for free passage in bypass passage, and aims at an improvement of flow characteristics.
[0002]
[Description of the Prior Art] In the centrifugal compressor used for a gas turbine, a turbocharger, etc., as the diffuser is used in order to aim at improvement in effectiveness, for example, shown in drawing 6 (a), an impeller 2 is supported pivotable in the compressor housing 1, a centrifugal force is given to the air which drew in from the air inlet of the compressor housing 1 by the impeller 2, and in a diffuser 3 and the scrolling section which is not illustrated, the kinetic energy is changed into pressure energy, and is sent out.
[0003] Thus, although there are a thing with a wing 4 and a thing without a wing and use in the comparatively large flow rate range is possible in a vaneless diffuser as kinetic energy is shown in the diffuser 3 changed into pressure energy at drawing 6 (b), the effectiveness and improvement in a compression ratio are small compared with a vaned diffuser (BENDO diffuser).
[0004] Then, changing throat area using the adjustable diffuser which made the vane of a battledore-and-shuttlecock diffuser adjustable structure, and improving flow characteristics is performed.
[0005]
[Problem(s) to be Solved by the Invention] However, when an adjustable diffuser is used, the clearance for moving a vane is required between a vane and housing of a fixed side, loss arises by the secondary flow of this clearance part, or the flow separation (exfoliation of a wall surface boundary layer) by change of an angle of attack etc. occurs, and there are problems, such as causing degradation other than a design point.
[0006] Moreover, there is a problem which exfoliation of the local boundary layer of flow produces also in a vaneless diffuser.
[0007] This invention was not made in view of the technical problem of this conventional technique, and it tends to offer the centrifugal compressor with a diffuser which can also improve the flow characteristics of a vaneless diffuser while it can improve flow characteristics, without changing a configuration, attachment structure, etc. of a vane of a battledore-and-shuttlecock diffuser.
[0008]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, it is characterized by the centrifugal compressor with a diffuser of this invention according to claim 1 coming to prepare the bypass passage which forms a bypass hole in the wall surface boundary-layer-separation section of the centrifugal compressor equipped with the diffuser, and opens this bypass hole and the low pressure section of a compressor suction side for free passage.
[0009] He is trying for a compressor suction side to make it bypass by the bypass hole and

bypass passage, exfoliation of a boundary layer is prevented, an engine-performance improvement is aimed at, and the flow characteristics of preventing a surging are made to improve according to this invention.
[0010] Moreover, in addition to a configuration according to claim 1, the centrifugal compressor with a diffuser of this invention according to claim 2 constitutes said diffuser from a battledore-and-shuttlecock diffuser, makes said wall surface boundary-layer-separation section the throat section of a diffuser, and is characterized by coming to form a bypass hole in this throat section.

[0011] He is trying to secure the flow rate which flows a diffuser part as is made to bypass, even if it makes the amount of discharge flow of a compressor small by the bypass hole and bypass passage, and the flow characteristics of preventing a surging are made to improve according to this invention.
[0012] Moreover, in addition to a configuration according to claim 1 or 2, the centrifugal compressor with a diffuser of this invention according to claim 3 is characterized by making the low pressure section of the suction side of said compressor into the low pressure section of an impeller, or the sink passage to an impeller.
[0013] It can be made to bypass effectively using the sink negative pressure of the low pressure section of an impeller, or the sink passage to an impeller, and the flow characteristics of preventing a surging certainly are made to improve according to this invention.
[0014] Furthermore, the centrifugal compressor with a diffuser of this invention according to claim 4 is characterized by constituting said bypass hole from the set section which opens the regions of back of two or more minor diameter holes and the minor diameter hole of these plurality for free passage in addition to a configuration according to claim 1 to 3.
[0015] Use a bypass hole as two or more holes, and he is trying to open regions of back for free passage in the set section, he prevents turbulence of the flow by the bypass hole as much as possible, and is trying to prevent degradation according to this invention.
[0016] Moreover, in addition to a configuration according to claim 2 to 4, the centrifugal compressor with a diffuser of this invention according to claim 5 is characterized by making the gross area of the bypass hole of the throat section of said diffuser into 20% or less of the total entry width of face of the throat section.
[0017] He is trying to restrict the gross area of a bypass hole to 20% or less of the total entry width of face of the throat section, and the degradation by the bypass hole or bypass passage is stopped within 1%, and he is trying to improve flow characteristics according to this invention, securing the engine performance.
[0018] Furthermore, the centrifugal compressor with a diffuser of this invention according to claim 6 is characterized by preparing the flow rate control means which controls a bypass flow rate in said bypass passage in addition to a configuration according to claim 1 to 5.
[0019] According to this invention, by the flow rate control means, a bypass flow rate can be changed now and it can operate now efficiently corresponding to operation, an operation rotational frequency, etc. according to the required amount of discharge flow.
[0020] Moreover, the centrifugal compressor with a diffuser of this invention according to claim 7 is characterized by in addition to a configuration according to claim 1 to 6, changing the throat area ratio of the bypass passage connection to the low pressure section of the suction side of said bypass hole and said compressor, and controlling a flow rate.
[0021] According to this invention, by choosing the area ratio of orifice appropriately, a bypass flow rate can be set up now and required flow characteristics can be acquired now.
[0022] Here, the wall surface boundary-layer-separation section of a centrifugal compressor can mean the part which flow separation produces in the suction side of a centrifugal compressor, for example, the throat section of a diffuser can be raised.
[0023] Furthermore, the throat section of a diffuser means a part with the smallest distance with the adjoining vane.
[0024] Moreover, the upstream of the sink passage to the part and impeller which the part which the low pressure section of a compressor suction side is a fluid's of compressor suction side, it absorbs, and negative pressure arises, and serves as low voltage force is said to, for example,

the periphery of an impeller counters can be raised.
[0025] Furthermore, if it says expressing the gross area of the bypass hole of the throat section of a diffuser with a numeric value as it is, and making it 20% or less, although it is not the value of a non-dimension in the gross area of a bypass hole, and the ratio of the total entry width of face of the throat section in 20% or less of the total entry width of face of the throat section and it is made larger than this, since original degradation is caused, it will be set as threshold value.
[0026] Moreover, a flow rate control means can mean what can carry out adjustment control of the flow rate, and a bulb etc. can be used.
[0027] Furthermore, a bypass hole and the area ratio of orifice of the bypass passage connection to the low pressure section of said impeller say the ratio of the magnitude of a bypass hole, and the area of the attachment section by the side of the impeller of bypass passage, and it enables it to control a flow rate by this.
[0028]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained to a detail based on a drawing. It is the front view with which drawing 1 started the gestalt of 1 operation of the centrifugal compressor with a diffuser of this invention, (a) extracted the sectional view of the principal part and (b) extracted the battledore-and-shuttlecock diffuser part.
[0029] The diffuser 13 arranged at the compressor housing 11 by the side of the appearance of the impeller 12 of the compressor supported by the compressor housing 11 pivotable is constituted from this centrifugal compressor 10 with a diffuser by the adjustable diffuser of battledore and shuttlecock, it can have the adjustable device which is not illustrated and wing (vane) 13a can be moved now.
[0030] The bypass hole 15 is formed in the smallest, the throat section 14 of the adjustable diffuser 13 of this battledore and shuttlecock, i.e., the distance between adjoining wing 13a, part at the mainstream direction and mainstream perpendicular of a fluid of a centrifugal compressor, and a mainstream part can be branched now from the bypass hole 15. And this bypass hole 15 is made to open the end section for free passage, the bypass passage 16 is connected, and it has connected with the compressor housing 11 of the impeller 12 whose other end is the low pressure section of a compressor suction side, and the entry section 17 which counters.
[0031] Therefore, some fluids (for example, air etc.) with which energy was added by the impeller 12 will be bled in the throat section 14 of the adjustable diffuser 13, recycling will be returned and carried out to the entry section 17 of an impeller 12, and only the part of the fluid flow rate breathed out through a diffuser 13 to the flow rate which flows an impeller 12 of a bleeding flow rate which flows the bypass passage 16 from the bypass hole 15 decreases. While being able to decrease the flow rate made to breathe out from a compressor, this securing the flow rate which flows an impeller 12, the throat section 14 of a diffuser 13 is a big factor which determines the flow rate limitation of a centrifugal compressor, and can improve the surging produced with a diffuser 13, and the flow rate limitation of a choke by bleeding from this part.
[0032] What is necessary is it to be effective that the improvement effect of flow characteristics forms in the most remarkable part as for the bypass hole 15 formed for an improvement of such flow characteristics, for example, to choose any one place based on an experimental result etc. among three places, three bypass holes 15-1 of the throat section 14 of a diffuser 13, 15-2, and 15-3, and just to make it form it, as shown in drawing 1 (b).
[0033] Next, drawing 2 explains the case where much more flow characteristics are considered as improvement use with a centrifugal compressor with a diffuser.
[0034] In this centrifugal compressor 10 with a diffuser, if two or more bypass holes 15 (the example of illustration five pieces) constitute the bypass hole 15 formed for an improvement of flow characteristics compared with the case where forming so that the mainstream from an impeller 12 may not be disturbed constitutes with one big hole desirably as shown in drawing 2 , it can lessen mainstream turbulence and can make degradation the minimum.
[0035] And what is necessary is to be referred to as set section 15a which forms a crevice in the compressor housing 11 used as the regions of back of the bypass hole 15, and opens each bypass hole 15 for free passage, and just to make it connect the end of the bypass passage 16

to this set section 15a, in constituting the bypass hole 15 from plurality.
[0036] Moreover, the other end of the bypass passage 16 which connected the end to set section 15a which opens the bypass hole 15 for free passage As it changes when open for free passage into the periphery section of the impeller 12 of a compressor, and compressor housing 11 part which counters, as drawing 1 explained, and shown in drawing 2 You may make it connect with the upstream of the sink passage 20 to an impeller 12, and it can absorb also in this case, and can be made to bypass effectively with the inhalation negative pressure of passage 20.
[0037] Furthermore, while flow characteristics, such as a surging critical discharge, change, the effectiveness of the whole centrifugal compressor also changes with the numbers and the gross areas of the bypass hole 15 in the case of constituting the bypass hole 15 from plurality in this way.
[0038] Then, as a bypass hole 15, as shown in drawing 2 (b), every five holes [a total of 20] per place were opened in the four throat sections 14 of circumferencial direction regular intervals, and it experimented in the performance characteristics changed and formed so that the gross area might become 15% and 30% to the width of face B of the throat section 14. Drawing 3 and drawing 4 showed the result, an axis of ordinate is a pressure ratio in a mass flow rate, drawing 3 changes [axis of abscissa] the rotational frequency N of a compressor with 40% of a design rotational frequency, 50%, 70%, and 80%, and drawing 4 is an effectiveness ratio when an axis of abscissa sets to 100 the case where an axis of ordinate sets bleeding surface ratio to 0, by bleeding surface ratio (when steam extraction is not performed).
[0039] Although it turns out that the surging critical discharge of a compressor can be made small by increasing bleeding area from drawing 3 so that clearly from these experiments, it turns out that the fall of the effectiveness ratio of a compressor is caused from drawing 4 by increase of bleeding surface ratio by one side.
[0040] Therefore, in order to suppress decline in a compressor efficiency within 1%, it can stop within limits which can permit degradation, improving flow characteristics, such as a surging limit, by carrying out like this that what is necessary is just to make the gross area of the bypass hole 15 20% or less to the width of face B of the throat section 14.
[0041] Furthermore, to be shown in drawing 2 and drawing 4 , the bulb 18 and control device 19 as a flow rate control means are infixed in the bypass passage 16 which opens the upstream of the sink passage 20 of the bypass hole 15 and an impeller 12, or the entry section 17 of the periphery of an impeller 12 for free passage, and the flow rate bled from the bypass hole 15 is controlled by this invention by opening adjustment of the bulb 18 by the control device 19.
[0042] It becomes possible to operate by this, without starting a surging etc. also at the time of starting of a gas turbine by opening the bulb 18 by the low-speed side, when a bleeding flow rate can be changed, for example, the engine speed of a centrifugal compressor is changed, even if bleeding area is fixed, and operating, and making it close by the high-speed side with the magnitude of the bypass hole 15.
[0043] Moreover, as the gross area of the bypass hole 15 of the throat section 14 of a diffuser 13 is absorbed, it considers as half [of the cross section of passage 20 or the bypass passage 16 of the entry section 17 of an impeller 12] and the area ratio of orifice is set to one half by such surface ratio, while being made to perform steam extraction smoothly, effect on the mainstream by the bypass hole 15 is lessened.
[0044] In addition, by rationalizing this area ratio of orifice, when the engine speed of a centrifugal compressor changes, a bleeding flow rate required to operate [for a surging to arise, and] so that there may be nothing can also be obtained.
[0045] As mentioned above, according to these invention, the throat section 14 of the adjustable diffuser 13 of battledore and shuttlecock is a big factor which determines the flow rate limitation of a centrifugal compressor, and can improve the flow characteristics of the surging which bleeds from the bypass hole 15 formed in this part, and he is trying to return to the low pressure sections, such as the entry section 17 of an impeller 12, and is produced with a diffuser, or a choke.
[0046] Moreover, the flow of the entry section 17 of an impeller 12 can be changed by the flow bled from the diffuser 13 by which the pressure up was carried out by the impeller 12, flow

characteristics are improved by this, and improvement in a surging limit etc. is performed.
[0047] Furthermore, structure is [that what is necessary is just to form the bypass hole 15 and the bypass passage 16, without changing a configuration, attachment structure, etc. of a vane of a diffuser at all] also easy.
[0048] In addition, although the gestalt of the above-mentioned operation explained the case of the centrifugal compressor equipped with the battledore-and-shuttlecock adjustable diffuser as a centrifugal compressor with a diffuser to the example, it is applicable similarly [the case of a diffuser with a stationary vane, or in the case of a vaneless diffuser], and exfoliation of the boundary layer of flow can be prevented, surging generating can be controlled, and expansion of a stable actuation region can be aimed at.
[0049] Moreover, it forms in the part which not only the throat section of a diffuser but local flow separation produces, and this invention can be applied to control of exfoliation, or the formation location of a bypass hole can also apply to a vaneless diffuser etc. (diaphragm configuration etc.).
[0050]
[Effect of the Invention] As mentioned above, since it was made for a compressor suction side to make it bypass by the bypass hole and bypass passage as concretely explained with the gestalt of operation according to the centrifugal compressor with a diffuser of this invention according to claim 1, exfoliation of a boundary layer can be prevented, an engine-performance improvement can be aimed at, and the flow characteristics of preventing a surging can be improved.
[0051] Furthermore, structure is [that what is necessary is just to form a bypass hole and bypass passage, without changing a configuration, attachment structure, etc. of a vane of a diffuser at all] also easy.
[0052] Moreover, since it was made to make it bypass according to the centrifugal compressor with a diffuser of this invention according to claim 2 even if it made the amount of discharge flow of a compressor small by the bypass hole and bypass passage, the flow rate which flows a diffuser part can be secured and the flow characteristics of preventing a surging can be improved.
[0053] Furthermore, according to the centrifugal compressor with a diffuser of this invention according to claim 3, since the low pressure section of the suction side of a compressor was made into the low pressure section of an impeller, or the sink passage to an impeller, it can be made to be able to bypass effectively using the sink negative pressure of the low pressure section of an impeller, or the sink passage to an impeller, and the flow characteristics of preventing a surging certainly can be improved.
[0054] Moreover, since according to the centrifugal compressor with a diffuser of this invention according to claim 4 a bypass hole is used as two or more holes and regions of back were opened for free passage in the set section, turbulence of the flow by the bypass hole can be prevented as much as possible, and degradation can be prevented.
[0055] Furthermore, since the gross area of a bypass hole was restricted to 20% or less, the degradation by the bypass hole or bypass passage is stopped within 1%, and flow characteristics are improvable [securing the engine performance] according to the centrifugal compressor with a diffuser of this invention according to claim 5.
[0056] Moreover, since the flow rate control means which controls a bypass flow rate was prepared in bypass passage according to the centrifugal compressor with a diffuser of this invention according to claim 6, by the flow rate control means, a bypass flow rate can be changed and it can operate efficiently corresponding to operation, an operation rotational frequency, etc. according to the required amount of discharge flow.
[0057] Furthermore, since according to the centrifugal compressor with a diffuser of this invention according to claim 7 the bypass hole of the throat section of a diffuser and the area ratio of orifice of the bypass passage connection to the low pressure section of said impeller are changed and the flow rate was controlled, by choosing the area ratio of orifice appropriately, a bypass flow rate can be set up now and required flow characteristics can be acquired.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] About amelioration of the centrifugal compressor equipped with the diffuser, this invention opens the wall surface boundary-layer-separation sections, such as the throat section of a diffuser, the low pressure section of the impeller of a compressor suction side, etc. for free passage in bypass passage, and aims at an improvement of flow characteristics.

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PRIOR ART

[Description of the Prior Art] In the centrifugal compressor used for a gas turbine, a turbocharger, etc., as the diffuser is used in order to aim at improvement in effectiveness, for example, shown in drawing 6 (a), an impeller 2 is supported pivotable in the compressor housing 1, a centrifugal force is given to the air which drew in from the air inlet of the compressor housing 1 by the impeller 2, and in a diffuser 3 and the scrolling section which is not illustrated, the kinetic energy is changed into pressure energy, and is sent out.
[0003] Thus, although there are a thing with a wing 4 and a thing without a wing and use in the comparatively large flow rate range is possible in a vaneless diffuser as kinetic energy is shown in the diffuser 3 changed into pressure energy at drawing 6 (b), the effectiveness and improvement in a compression ratio are small compared with a vaned diffuser (BENDO diffuser).
[0004] Then, changing throat area using the adjustable diffuser which made the vane of a battledore-and-shuttlecock diffuser adjustable structure, and improving flow characteristics is performed.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, since it was made for a compressor suction side to make it bypass by the bypass hole and bypass passage as concretely explained with the gestalt of operation according to the centrifugal compressor with a diffuser of this invention according to claim 1, exfoliation of a boundary layer can be prevented, an engine-performance improvement can be aimed at, and the flow characteristics of preventing a surging can be improved.
[0051] Furthermore, structure is [that what is necessary is just to form a bypass hole and bypass passage, without changing a configuration, attachment structure, etc. of a vane of a diffuser at all] also easy.
[0052] Moreover, since it was made to make it bypass according to the centrifugal compressor with a diffuser of this invention according to claim 2 even if it made the amount of discharge flow of a compressor small by the bypass hole and bypass passage, the flow rate which flows a diffuser part can be secured and the flow characteristics of preventing a surging can be improved.
[0053] Furthermore, according to the centrifugal compressor with a diffuser of this invention according to claim 3, since the low pressure section of the suction side of a compressor was made into the low pressure section of an impeller, or the sink passage to an impeller, it can be made to be able to bypass effectively using the sink negative pressure of the low pressure section of an impeller, or the sink passage to an impeller, and the flow characteristics of preventing a surging certainly can be improved.
[0054] Moreover, since according to the centrifugal compressor with a diffuser of this invention according to claim 4 a bypass hole is used as two or more holes and regions of back were opened for free passage in the set section, turbulence of the flow by the bypass hole can be prevented as much as possible, and degradation can be prevented.
[0055] Furthermore, since the gross area of a bypass hole was restricted to 20% or less, the degradation by the bypass hole or bypass passage is stopped within 1%, and flow characteristics are improvable [securing the engine performance] according to the centrifugal compressor with a diffuser of this invention according to claim 5.
[0056] Moreover, since the flow rate control means which controls a bypass flow rate was prepared in bypass passage according to the centrifugal compressor with a diffuser of this invention according to claim 6, by the flow rate control means, a bypass flow rate can be changed and it can operate efficiently corresponding to operation, an operation rotational frequency, etc. according to the required amount of discharge flow.
[0057] Furthermore, since according to the centrifugal compressor with a diffuser of this invention according to claim 7 the bypass hole of the throat section of a diffuser and the area ratio of orifice of the bypass passage connection to the low pressure section of said impeller are changed and the flow rate was controlled, by choosing the area ratio of orifice appropriately, a bypass flow rate can be set up now and required flow characteristics can be acquired.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when an adjustable diffuser is used, the clearance for moving a vane is required between a vane and housing of a fixed side, loss arises by the secondary flow of this clearance part, or the flow separation (exfoliation of a wall surface boundary layer) by change of an angle of attack etc. occurs, and there are problems, such as causing degradation other than a design point.
[0006] Moreover, there is a problem which exfoliation of the local boundary layer of flow produces also in a vaneless diffuser.
[0007] This invention was not made in view of the technical problem of this conventional technique, and it tends to offer the centrifugal compressor with a diffuser which can also improve the flow characteristics of a vaneless diffuser while it can improve flow characteristics, without changing a configuration, attachment structure, etc. of a vane of a battledore-and-shuttlecock diffuser.

[Translation done.]

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MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, it is characterized by the centrifugal compressor with a diffuser of this invention according to claim 1 coming to prepare the bypass passage which forms a bypass hole in the wall surface boundary-layer-separation section of the centrifugal compressor equipped with the diffuser, and opens this bypass hole and the low pressure section of a compressor suction side for free passage.
[0009] He is trying for a compressor suction side to make it bypass by the bypass hole and bypass passage, exfoliation of a boundary layer is prevented, an engine-performance improvement is aimed at, and the flow characteristics of preventing a surging are made to improve according to this invention.
[0010] Moreover, in addition to a configuration according to claim 1, the centrifugal compressor with a diffuser of this invention according to claim 2 constitutes said diffuser from a battledore-and-shuttlecock diffuser, makes said wall surface boundary-layer-separation section the throat section of a diffuser, and is characterized by coming to form a bypass hole in this throat section.

[0011] He is trying to secure the flow rate which flows a diffuser part as is made to bypass, even if it makes the amount of discharge flow of a compressor small by the bypass hole and bypass passage, and the flow characteristics of preventing a surging are made to improve according to this invention.
[0012] Moreover, in addition to a configuration according to claim 1 or 2, the centrifugal compressor with a diffuser of this invention according to claim 3 is characterized by making the low pressure section of the suction side of said compressor into the low pressure section of an impeller, or the sink passage to an impeller.
[0013] It can be made to bypass effectively using the sink negative pressure of the low pressure section of an impeller, or the sink passage to an impeller, and the flow characteristics of preventing a surging certainly are made to improve according to this invention.
[0014] Furthermore, the centrifugal compressor with a diffuser of this invention according to claim 4 is characterized by constituting said bypass hole from the set section which opens the regions of back of two or more minor diameter holes and the minor diameter hole of these plurality for free passage in addition to a configuration according to claim 1 to 3.
[0015] Use a bypass hole as two or more holes, and he is trying to open regions of back for free passage in the set section, he prevents turbulence of the flow by the bypass hole as much as possible, and is trying to prevent degradation according to this invention.
[0016] Moreover, in addition to a configuration according to claim 2 to 4, the centrifugal compressor with a diffuser of this invention according to claim 5 is characterized by making the gross area of the bypass hole of the throat section of said diffuser into 20% or less of the total entry width of face of the throat section.
[0017] He is trying to restrict the gross area of a bypass hole to 20% or less of the total entry width of face of the throat section, and the degradation by the bypass hole or bypass passage is stopped within 1%, and he is trying to improve flow characteristics according to this invention, securing the engine performance.
[0018] Furthermore, the centrifugal compressor with a diffuser of this invention according to

claim 6 is characterized by preparing the flow rate control means which controls a bypass flow rate in said bypass passage in addition to a configuration according to claim 1 to 5.
[0019] According to this invention, by the flow rate control means, a bypass flow rate can be changed now and it can operate now efficiently corresponding to operation, an operation rotational frequency, etc. according to the required amount of discharge flow.
[0020] Moreover, the centrifugal compressor with a diffuser of this invention according to claim 7 is characterized by in addition to a configuration according to claim 1 to 6, changing the throat area ratio of the bypass passage connection to the low pressure section of the suction side of said bypass hole and said compressor, and controlling a flow rate.
[0021] According to this invention, by choosing the area ratio of orifice appropriately, a bypass flow rate can be set up now and required flow characteristics can be acquired now.
[0022] Here, the wall surface boundary-layer-separation section of a centrifugal compressor can mean the part which flow separation produces in the suction side of a centrifugal compressor, for example, the throat section of a diffuser can be raised.
[0023] Furthermore, the throat section of a diffuser means a part with the smallest distance with the adjoining vane.
[0024] Moreover, the upstream of the sink passage to the part and impeller which the part which the low pressure section of a compressor suction side is a fluid's of compressor suction side, it absorbs, and negative pressure arises, and serves as low voltage force is said to, for example, the periphery of an impeller counters can be raised.
[0025] Furthermore, if it says expressing the gross area of the bypass hole of the throat section of a diffuser with a numeric value as it is, and making it 20% or less, although it is not the value of a non-dimension in the gross area of a bypass hole, and the ratio of the total entry width of face of the throat section in 20% or less of the total entry width of face of the throat section and it is made larger than this, since original degradation is caused, it will be set as threshold value.
[0026] Moreover, a flow rate control means can mean what can carry out adjustment control of the flow rate, and a bulb etc. can be used.
[0027] Furthermore, a bypass hole and the area ratio of orifice of the bypass passage connection to the low pressure section of said impeller say the ratio of the magnitude of a bypass hole, and the area of the attachment section by the side of the impeller of bypass passage, and it enables it to control a flow rate by this.
[0028]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained to a detail based on a drawing. It is the front view with which drawing 1 started the gestalt of 1 operation of the centrifugal compressor with a diffuser of this invention, (a) extracted the sectional view of the principal part and (b) extracted the battledore-and-shuttlecock diffuser part.
[0029] The diffuser 13 arranged at the compressor housing 11 by the side of the appearance of the impeller 12 of the compressor supported by the compressor housing 11 pivotable is constituted from this centrifugal compressor 10 with a diffuser by the adjustable diffuser of battledore and shuttlecock, it can have the adjustable device which is not illustrated and wing (vane) 13a can be moved now.
[0030] The bypass hole 15 is formed in the smallest, the throat section 14 of the adjustable diffuser 13 of this battledore and shuttlecock, i.e., the distance between adjoining wing 13a, part at the mainstream direction and mainstream perpendicular of a fluid of a centrifugal compressor, and a mainstream part can be branched now from the bypass hole 15. And this bypass hole 15 is made to open the end section for free passage, the bypass passage 16 is connected, and it has connected with the compressor housing 11 of the impeller 12 whose other end is the low pressure section of a compressor suction side, and the entry section 17 which counters.
[0031] Therefore, some fluids (for example, air etc.) with which energy was added by the impeller 12 will be bled in the throat section 14 of the adjustable diffuser 13, recycling will be returned and carried out to the entry section 17 of an impeller 12, and only the part of the fluid flow rate breathed out through a diffuser 13 to the flow rate which flows an impeller 12 of a bleeding flow rate which flows the bypass passage 16 from the bypass hole 15 decreases. While being able to

decrease the flow rate made to breathe out from a compressor, this securing the flow rate which flows an impeller 12, the throat section 14 of a diffuser 13 is a big factor which determines the flow rate limitation of a centrifugal compressor, and can improve the surging produced with a diffuser 13, and the flow rate limitation of a choke by bleeding from this part.

[0032] What is necessary is it to be effective that the improvement effect of flow characteristics forms in the most remarkable part as for the bypass hole 15 formed for an improvement of such flow characteristics, for example, to choose any one place based on an experimental result etc. among three places, three bypass holes 15-1 of the throat section 14 of a diffuser 13, 15-2, and 15-3, and just to make it form it, as shown in drawing 1 (b).

[0033] Next, drawing 2 explains the case where much more flow characteristics are considered as improvement use with a centrifugal compressor with a diffuser.

[0034] In this centrifugal compressor 10 with a diffuser, if two or more bypass holes 15 (the example of illustration five pieces) constitute the bypass hole 15 formed for an improvement of flow characteristics compared with the case where forming so that the mainstream from an impeller 12 may not be disturbed constitutes with one big hole desirably as shown in drawing 2 , it can lessen mainstream turbulence and can make degradation the minimum.

[0035] And what is necessary is to be referred to as set section 15a which forms a crevice in the compressor housing 11 used as the regions of back of the bypass hole 15, and opens each bypass hole 15 for free passage, and just to make it connect the end of the bypass passage 16 to this set section 15a, in constituting the bypass hole 15 from plurality.

[0036] Moreover, the other end of the bypass passage 16 which connected the end to set section 15a which opens the bypass hole 15 for free passage As it changes when open for free passage into the periphery section of the impeller 12 of a compressor, and compressor housing 11 part which counters, as drawing 1 explained, and shown in drawing 2 You may make it connect with the upstream of the sink passage 20 to an impeller 12, and it can absorb also in this case, and can be made to bypass effectively with the inhalation negative pressure of passage 20.

[0037] Furthermore, while flow characteristics, such as a surging critical discharge, change, the effectiveness of the whole centrifugal compressor also changes with the numbers and the gross areas of the bypass hole 15 in the case of constituting the bypass hole 15 from plurality in this way.

[0038] Then, as a bypass hole 15, as shown in drawing 2 (b), every five holes [a total of 20] per place were opened in the four throat sections 14 of circumferencial direction regular intervals, and it experimented in the performance characteristics changed and formed so that the gross area might become 15% and 30% to the width of face B of the throat section 14. Drawing 3 and drawing 4 showed the result, an axis of ordinate is a pressure ratio in a mass flow rate, drawing 3 changes [axis of abscissa] the rotational frequency N of a compressor with 40% of a design rotational frequency, 50%, 70%, and 80%, and drawing 4 is an effectiveness ratio when an axis of abscissa sets to 100 the case where an axis of ordinate sets bleeding surface ratio to 0, by bleeding surface ratio (when steam extraction is not performed).

[0039] Although it turns out that the surging critical discharge of a compressor can be made small by increasing bleeding area from drawing 3 so that clearly from these experiments, it turns out that the fall of the effectiveness ratio of a compressor is caused from drawing 4 by increase of bleeding surface ratio by one side.

[0040] Therefore, in order to suppress decline in a compressor efficiency within 1%, it can stop within limits which can permit degradation, improving flow characteristics, such as a surging limit, by carrying out like this that what is necessary is just to make the gross area of the bypass hole 15 20% or less to the width of face B of the throat section 14.

[0041] Furthermore, to be shown in drawing 2 and drawing 4 , the bulb 18 and control device 19 as a flow rate control means are infixed in the bypass passage 16 which opens the upstream of the sink passage 20 of the bypass hole 15 and an impeller 12, or the entry section 17 of the periphery of an impeller 12 for free passage, and the flow rate bled from the bypass hole 15 is controlled by this invention by opening adjustment of the bulb 18 by the control device 19.

[0042] It becomes possible to operate by this, without starting a surging etc. also at the time of starting of a gas turbine by opening the bulb 18 by the low-speed side, when a bleeding flow rate

can be changed, for example, the engine speed of a centrifugal compressor is changed, even if bleeding area is fixed, and operating, and making it close by the high-speed side with the magnitude of the bypass hole 15.

[0043] Moreover, as the gross area of the bypass hole 15 of the throat section 14 of a diffuser 13 is absorbed, it considers as half [of the cross section of passage 20 or the bypass passage 16 of the entry section 17 of an impeller 12] and the area ratio of orifice is set to one half by such surface ratio, while being made to perform steam extraction smoothly, effect on the mainstream by the bypass hole 15 is lessened.

[0044] In addition, by rationalizing this area ratio of orifice, when the engine speed of a centrifugal compressor changes, a bleeding flow rate required to operate [for a surging to arise, and] so that there may be nothing can also be obtained.

[0045] As mentioned above, according to these invention, the throat section 14 of the adjustable diffuser 13 of battledore and shuttlecock is a big factor which determines the flow rate limitation of a centrifugal compressor, and can improve the flow characteristics of the surging which bleeds from the bypass hole 15 formed in this part, and he is trying to return to the low pressure sections, such as the entry section 17 of an impeller 12, and is produced with a diffuser, or a choke.

[0046] Moreover, the flow of the entry section 17 of an impeller 12 can be changed by the flow bled from the diffuser 13 by which the pressure up was carried out by the impeller 12, flow characteristics are improved by this, and improvement in a surging limit etc. is performed.

[0047] Furthermore, structure is [that what is necessary is just to form the bypass hole 15 and the bypass passage 16, without changing a configuration, attachment structure, etc. of a vane of a diffuser at all] also easy.

[0048] In addition, although the gestalt of the above-mentioned operation explained the case of the centrifugal compressor equipped with the battledore-and-shuttlecock adjustable diffuser as a centrifugal compressor with a diffuser to the example, it is applicable similarly [the case of a diffuser with a stationary vane, or in the case of a vaneless diffuser], and exfoliation of the boundary layer of flow can be prevented, surging generating can be controlled, and expansion of a stable actuation region can be aimed at.

[0049] Moreover, it forms in the part which not only the throat section of a diffuser but local flow separation produces, and this invention can be applied to control of exfoliation, or the formation location of a bypass hole can also apply to a vaneless diffuser etc. (diaphragm configuration etc.).

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the front view with which the gestalt of 1 operation of the centrifugal compressor with a diffuser of this invention was started, (a) extracted the sectional view of the principal part and (b) extracted the battledore-and-shuttlecock diffuser part.
[Drawing 2] It is the front view with which the gestalt of other 1 operations of the centrifugal compressor with a diffuser of this invention was started, (a) extracted the sectional view of the principal part and (b) extracted the battledore-and-shuttlecock diffuser part.
[Drawing 3] It is the graph which the rotational frequency N of a compressor is changed and shows the relation of the mass flow rate and pressure ratio concerning the gestalt of 1 operation of the centrifugal compressor with a diffuser of this invention.
[Drawing 4] It is the graph which shows the relation between the bleeding surface ratio concerning the gestalt of 1 operation of the centrifugal compressor with a diffuser of this invention, and an effectiveness ratio.
[Drawing 5] It is the sectional view of the principal part of the centrifugal compressor with a diffuser of this invention which starts the gestalt of other operations further.
[Drawing 6] It is the fragmentary sectional view and partial front view of attachment structure equipped with the conventional vaned diffuser of a centrifugal compressor.
[Description of Notations]
10 Centrifugal Compressor with Diffuser
11 Compressor Housing
12 Impeller
13 Battledore-and-Shuttlecock Adjustable Diffuser
13a Vane (wing)
14 Throat Section
15 Bypass Hole
15a Set section
16 Bypass Passage
17 Entry Section
18 Bulb
19 Control Unit
20 Sink Passage
B Width of face of the throat section

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